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PALYNOLOGICAL INVESTIGATIONS ON SEDIMENTS OF THE LOWER DANIAN (FISH CLAY, DENMARK) II

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ABSTRACT

This paper, which is the second and the final report of the palynological investigations on lower Danian Fish Clay layers, summarize the *Pteridophyte* spores and the *Gymnospermous* pollen grains. Fifty form-species were demonstrated, of these 47 are spores, and only three *Gymnospermous* pollen grains. The new taxa are as follows: *Leiotriletes hojrupensis, Triremisporites minor, Disthamulatisporites daniensis, Biretisporites croxtonae, Granulatisporites concavus, Verreticulisporis bangii, Verrucosisporites stockmarrii, Phaeocerosporites croxtonae, Phaeocerosporites stockmarrii, Phaeocerosporites bangii, Croxtonaesporites hojrupensis, Croxtonaesporites daniensis, Polypodiaceoisporites hojrupensis, Polypodiaceoisporites stockmarrii, Polypodiaceoisporites bangii, Polypodiaceoisporites croxtonae, Verrucingulatisporites hojrupensis, Segmentizonosporites daniense, Inundatisporites krutzschii.* The botanical affinities of the spores can be well establish. The contribution of the tropical elements in the spore-pollen assemblage is important; these taxa are: *Cyatheaceae, Schizaeaceae, Gleicheniaceae, Pteridaceae.*

It is noteworthy that the *Lycopodiaceae* spores, and in particular of the livermoss spores *(Anthocerotaceae)*, are present and which are interpreted to indicate a marshy ecological condition of the sedimentary basin border.

INTRODUCTION

In a previous publication (KEDVES, 1979), the problems of the subjects the material and methods were published so that these topics will not be dealt with. The emphasis of this paper is the taxonomy of the spores and gymnospermous pollen grains and their interpretation.

RESULTS

Fgen.: LEIOTRILETES (NAUMOVA 1937) R. POT. et KRP. 1954.

1. *Leiotriletes hojrupensis* n. fsp. (Plate I, fig. 1, 2)

Diagnosis

Equatorial contour triangular with straight or slightly concave sides. Surface smooth. Wall thickening is general 0.7 μ, two layered with the two layers being equal. The laesurae are long, but not extend to the apices of the spore, r=4/5. Near the laesures there is a torus like thickening.

Maximum size: 36 μ (25—38 μ).

Holotype: Plate I, 1, 2, slide D_2—1—3, co-ordinates 6.4/110.2.

Locus typicus: Højrup.

Stratum typicum: Fish Clay.

Derivatio nominis: From Højrup of the locality type.
Differential diagnosis: The longer laesurae of this species make it distinct from *L. tenuis* (LESCHIK 1955) BHARDWAJ and SINGH 1964, and from the *L. balowensis* DÖRING 1965. The thinner wall of this new taxon separate well from *L. regularis* (PF. 1953) W. KR. 1959, and from *L. neddenioides* W. KR. 1962.
Botanical affinity: Cf. *Schizaeaceae.*
Occurrence: Højrup, Højstrup, Stevns Klint.

Fgen.: CYATHIDITES COUPER 1953.

1. *Cyathidites minor* COUPER 1953 (Plate I. fig. 3, 4)

Botanical affinity: After COUPER (1953) the genus Cyathea; based on SLADKOV's (1961) publication, the genus *Coniogramma* may be a possible affinity.
Occurrence: Højrup.

Fgen.: TRIREMISPORITES DELCOURT and SPRUMONT 1957.

1. *Triremisporites delcourti* DÖRING 1965 (Plate I, fig. 5, 6)

Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup, Højstrup.

2. *Triremisporites minor* n. fsp. (Plate I, fig. 7, 8)

Diagnosis

Equatorial contour is triangular with concave sides. Surface smooth. The laesurae extend to the apices of the spore. On the apices the wall is very thin, in general 0.5 µ. On the sides, between the apices the thickening is maximally 2—3 µ.
Maximum size: 20—24 µ.
Holotype: Plate I, 7, 8, slide D_2—1—5, co-ordinates 9.6/108.3.
Locus typicus: Hørup.
Stratum typicum: Fish Clay.
Derivatio nominis: From the small size.
Differential diagnosis: The *G. laetus* (BOLCH, 1953) is more concave than this new form-species.
Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup.
Remark. — A synthesis of the distribution of *Gleicheniaceae* in the geological past was published by BOLKHOVITINA (1966).

Fgen.: CONCAVISPORITES PF. 1953.

1. *Concavisporites laeviconcavus* W. KR. 1959 (Plate I, fig. 9, 10)

Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup.

Fgen.: OBTUSISPORIS (W. KR. 1959) POCOCK 1970

1. *Obtusisporis obtusangulus* (R. POT. 1934) W. KR. 1959 (Plate I, fig, 11—14)

Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup.

2. *Obtusisporis minimus* W. KR. 1962 (Plate I, fig. 15—18)

Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup, Højstrup.
Remark. — KRUTZSCH (1962) described this form-species from upper Tertiary layers of eastern Germany; these specimens are probably rebedded. Later, KRUTZSCH and VANHOORNE (1977) found forms similar to the *Gleicheniidites apilobatus* BRENNER 1963 (pl. 2a, b) in the Paleocene layers.

Fgen.: DISTHAMULATISPORITES n. fgen.

Fgen. typus: *Disthamulatisporites daniensis* n. fsp. (Plate I, fig. 19—22)

Diagnosis

Trilete spores, contour concave. The leasurae of the tetrad scar are long, reach to or almost to the contour of the spore. Proximal surface is smooth, the distale ornamentation is hamulate. Sometimes a small obtusi formation may also occur.
Genus type: Plate I, 19, 20, slide D_2—1—x—1, 16.5/113.9.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: From the characteristic distal ornamentation.
Differential diagnosis: The hamulate sculpture of the distal side make this taxon distinct from *Obtusisporis* (W. KR. 1959) POCOCK 1970.

1. *Disthamulatisporites daniensis* n. fsp. (Plate I, fig. 19—22)

Diagnosis

Equatorial contour concave with rounded apices. Proximal surface smooth or scabrate. The laesurae are long, and sometimes extend to the equatorial contour, r=4/5—5/5. The thickness of the ectexospore is below 1 μ, and two layered; the two layers are on equal thickness. The hamulate sculpture of the distal surface is well shown, the elements of the ornamentation are 0.5 μ large.
Maximum size: 20—28 μ.
Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup, Højstrup.
Remark. — For further information, see the form-generic description.

Fgen.: UNDULATISPORITES PF. 1953.

1. *Undulatisporites undulapolus* BRENNER 1963 (Plate I, fig. 23—26)
Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup.

2. *Undulatisporites elsikii* FREDERIKSEN 1973 (Plate I, fig. 27, 28, plate II, fig. 1, 2)
Remark . — FREDERIKSEN (1973) described this species from Eocene layers; from the work of ELSIK (1968) this species is well known from the Paleocene of Texas. There is a probable connection of this species with the form-genus *Biretisporites* DELCOURT and SPRUMONT 1955.
Botanical affinity: *Gleicheniaceae.*
Occurrence: Højrup, Stevns Klint.

Fgen.: BIRETISPORITES DELCOURT and SPRUMONT 1955.

1. *Biretisporites croxtonae* n. fsp. (Plate II, fig. 3, 4)

Diagnosis

Equatorial contour is circular to triangular with convex sides and rounded apices. The thickness of the wall is 1 μ about. The surface is finely granular some times covered with coni. The laesurae extend almost to the equator, but r=4/4. On the laesurae, there well definited lamellar thickenings.
Maximum size: 45—60 μ.
Holotype: Plate II, 3, 4, slide Stevns Klint—4; 11.4/115.2.
Locus typicus: Stevns Klint.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. I. C. CROXTON.
Differential diagnosis: The form of the equatorial contour distinct from *B. potoniei*

DELC. and SPRUM. 1955, *B. spectabilis* DETTMANN 1963 and from *B. convexus* SAH and KAR 1969; greater in size than *B. bellus* SAH and KAR 1969, thinner walled and a different equatorial contour than *B. crassilabratus* ARCHANGELSKY 1972.

Fgen.: GRANULATISPORITES (IBR. 1933) R. POT. and KRP. 1954.

1. *Granulatisporites concavus* n. fsp. (Plate II, fig. 5, 6)

Diagnosis

Equatorial contour triangular with concave sides and largely rounded apices. The laesurae of the tetrad square does not reach the equator, r=2/3—3/4. The exospore is thin, on the average 0.7 μ. Surface finely granular, granules 1.5—2.5 μ, in diameter. Maximum size: 33—40 μ.

Holotype: Plate II, 5, 6, slide Højstrup—1, co-ordinates 16.4/104.5.

Locus typicus: Højstrup.

Stratum typicum: Fish Clay.

Derivatio nominis: From the equatorial contour of the spore.

Differential diagnosis: The ornamentation of *G. palaeogenicus* KDS. 1966a is uniform and more dense than this new form-species.

Occurrence: For the time being, it is only known from the type locality.

Fgen.: ISCHYOSPORITES BALME 1957.

1. *Ischyosporites asolidus* (W. KR. 1959) W. KR. 1967 (Plate II, fig. 7, 8)

Occurrence: Højrup.

Botancial affinity: *Schizaeaceae, Lygodium.*

Fgen.: TRILITES COOKSON 1947 ex COUPER 1953, W. KR. 1967.

1. *Trilites triangulus* KDS. 1966 (Plate II, fig. 9, 10)

Occurrence: Højrup.

Botanical affinity: *Schizaeaceae, Lygodium.*

2. *Trilites paravallatus* W. KR. 1959 (Plate II, fig. 11, 12)

Occurrence: Højrup.

Botancial affinity: *Schizaeaceae, Lygodium.*

Fgen.: VERRETICULISPORIS W. KR. 1959.

1. *Verreticulisporis bangii* n. fsp. (Plate II, fig. 13, 14)

Diagnosis

Equatorial contour is triangular with convex sides. The laesurae extend or almost reach the apices of the spore, r=4/5—5/5. The exospore is 1—1.2 μ thick, two layered, the external layer is a little thicker than the inner layer. The verrucae are flat with a diameter of 1—2 μ and form a negative reticulum.

Maximum size: 30—40 μ.

Holotype: Plate II, 13, 14, slide D_3—49, co-ordinates 16.5/120.9.

Locus typicus: Højrup.

Stratum typicum: Fish Clay.

Derivatio nominis: In honour of Dr. I. BANG.

Differential diagnosis: The thinner exospore and the longer laesurae make this species distinct from *V. eoverrucosus* W. KR. 1959.

Occurrence: At present this taxon is only known from the type locality.

Botanical affinity: *Pteropsida.*

Fgen.: VERRUCOSISPORITES IBRAHIM 1933.

1. *Verrucosisporites stockmarrii* n. fsp. (Plate II, fig. 15, plate III, fig. 1).

Diagnosis

Equatorial contour is triangular with convex sides and rounded apices. Exospore is 1—1.5 μ thick, two layered, with each layer having approximately the same thickness. The laesurae are relatively short, r=1/2—3/4. The ornamentation is irregular, mostly rugulate, but sometimes verrucate; the size of the sculptural elements is 1.5—2.5 μ.
Maximum size: 38—44 μ.
Holotype: Plate II, 15, plate III, 1, slide Højstrup—49, co-ordinates 8.6/111.9.
Locus typicus: Højstrup.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. J. STOCKMARR.
Differential diagnosis: The smaller size and the larger ornamental elements distinguish this species from *V. quintus* (TH. and PF. 1953) W. KR. 1959.
Occurrence: At present this taxon is only known from the type locality.
Botanical affinity: *Osmundaceae* or *Schizaeaceae.*

Fgen.: FOVEOTRILETES VAN DER HAMMEN 1954 ex R. POT. 1956.
1. *Foveotriletes* fsp. (Palate III, fig. 2, 3)
Occurrence: Stevns Klint.
Botanical affinity: *Pteridophyte.*

Fgen.: RETITRILETES (VAN DER HAMMEN 1956 ex PIERCE) emend. DÖ., W-KR., MAI, and SCH. 1963.
1. *Retitriletes incomptus* (MANUM 1962) W. KR. 1963 (Plate III, fig. 4, 5)
Occurrence: Højrup.
Botanical affinity: *Lycopodiaceae.*

Fgen.: SAXOSPORIS W. KR. 1963.
1. *Saxosporis* fsp. ex groupe *gracilis* W. KR. and PACLTOVÁ 1963 (Plate III fig. 6, 7)
Occurrence: Højrup.
Botanical affinity: *Anthocerotaceae, Phaeoceros.*
2. *Saxosporis disconformis* (STOVER 1973) n. comb. (Plate III, fig. 8, 9)
Syn.: 1973, STOVER, in STOVER and PARTRIDGE, *Baculatisporites disconformis* STOVER n. sp., p. 245, 246, pl. 13, 8.
Occurrence: Højstrup, Stevns Klint.
Botanical affinity: *Anthocerotaceae.*

Fgen.: ECHINATISPORIS W. KR. 1959.
1. *Echinatisporis* fsp. (Plate III, fig. 10, 11)
Occurrence: Højstrup.
Botanical affinity: *Selaginellaceae, Selaginella.*

Fgen.: PHAEOCEROSPORITES E. NAGY 1968, here emended
Emended diagnosis
Trilete spores, contour circular or extremely convex, triangular. The laesurae extend to the equatorial contour; around the laesurae there are characteristic exospore thickenings. The wall of the spore is relatively thick. The proximal surface is smooth or scabrate. The ornamentation of the distal surface is variable, circular, polar annulus or half-moon-shaped thickenings or sometimes granules, verrucae or irregular thickenings.
Remark. — KRUTZSCH (1963) modified the description of *Foraminisporis* W. KR. 1959 by additional notes the original diagnosis remains however intact; he didnt

emended it so that *Foraminisporis zonaloides* W. KR. 1963 must be reclassified so that *Foraminisporis* W. KR. 1959 will not be a heterogenous form-genus. The conception of KRUTZSCH (1963) was accepted without criticism by PACLTOVÁ and SIMONCSICS (1970).

Phaeocerosporites zonaloides (W. KR. 1963) n. comb. Syn.: 1963, KRUTZSCH. — *Foraminisporis zonaloides* n. fsp., p. 40, pl. 1, 1—6.

1. *Phaeocerosporites croxtonae* n. fsp. (Plate III, fig. 12, 13)

Diagnosis

Equatorial contour is circular. Proximal surface scabrate or punctate. The laesurae of the tetrad scar extend to the equator bifurcating near the equator. The thickening on each side of the laesurae is 1.5—2 μ. Exospore is 2—2.3 μ thick, two layered, the external layer is thicker than the inner. The external part of the spore wall is channelled, similar to the tubulate structure. Around the distal pole there are three half-moon or asymmetrical annuli that form thickenings. Moreover, there are granules or verrucae with a base diameter of 1—3 μ.

Maximum size: 32—40 μ.

Holotype: Plate III, 12, 13, slide Højstrup—50, co-ordinates 14.3/103.8.

Locus typicus: Højstrup.

Stratum typicum: Fish Clay.

Derivatio nominis: In honour of Dr. I. C. CROXTON.

Differential diagnosis: The very characteristic three thickening around the distal pole distinguish well this taxon from the other species of this form-genus.

Occurrence: From the time being, it is only known from the type locality.

Botanical affinity: *Anthocerotaceae.*

2. *Phaeocerosporites stockmarrii* n. fsp. (Plate IV, fig. 1, 2)

Diagnosis

Equatorial contour circular or elliptical. Proximal surface is finely granular. The laesurae of the tetrad scar extend to the equator and divide before reaching the equatorial contour. Near the laesures there are large, 3 μ uncharacteristic thickenings. The exospore is 2 μ thick, two layered, the external wall is thicker than the internal one. The external wall is transversed by channels; structure tubulate. The most characteristic feature of the distal ornamentation is a polar, asymmetrical annulus, or U form thickening. Adjacent to them are granules with 1—2.5 μ diameter.

Maximum size: 30—45 μ.

Holotype: Plate IV, 1, 2 slide Højstrup—6, co-ordinates 7.4/107.0.

Locus typicus: Højstrup.

Stratum typicum: Fish Clay.

Derivatio nominis: In honour of Dr. J. STOCKMARR.

Differential diagnosis: The distal annulus or U form thickening distinguishes this species from *Ph. baranyaensis* E. NAGY 1968.

Occurrence: Højstrup, Stevns Klint.

Botanical affinity: *Anthocerotaceae.*

3. *Phaeocerosporites bangii* n. fsp. (Plate IV, fig. 3, 4)

Diagnosis

Equatorial contour is circular or triangular with convexe sides. Proximal surface is finely granular. The laesurae of the tetrad scar extend to the equator and divide near the equator. Around the laesurae, the thickening is 1.5 μ wide. The wall is 2 μ thick, in general two layered; the external wall is thicker than the internal, the external wall is channelled. The distal surface is granular, the size of the sculptural

elements range from 0.5 to 2.5 μ. The important distal characteristic feature is the irregular thickenings around the distal pole.
Maximum size: 28—34 μ.
Holotype: Plate IV, 3, 4, slide Stevns Klint—20, co-ordinates 5.1/102.8.
Locus typicus: Høstrup.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. I. BANG.
Differential diagnosis: The form of the distal pole thickenings is irregular. This characteristic feature distinguishes this taxon from *Ph. croxtonae* n. fsp. On the distal pole of the latter form-species, three half-moon thickenings are formed around the distal pole.

Occurrence: From the time being, this species is only known from the type locality.
Botanical affinity: *Anthocerotaceae.*

Fgen.: CROXTONAESPORITES n. fgen.
Fgen. type: *Croxtonaesporites hojrupensis* n. fsp. (Plate IV, fig. 5, 6)

Diagnosis

Zonotrilete spores, cingulum is not undulating and on the sides and at the apices. it has the same thickness. There are tori around the laesurae; the proximal and the distal surfaces of the central body are smooth.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. I. C. CROXTON.
Differential diagnosis: The torus on the apices of *Toricingulatisporites* SIMONCSICS 1964 described from the neogene deposits penetrate into the cingulum so that there is essentially a segmented cingulum, which has a diagnostic character. This features is not observable on the spores from the Fish Clay.

1. *Croxtonaesporites hojrupensis* n. fsp. (Plate IV, fig. 5, 6)

Diagnosis

Equatorial contour is triangular with straight or slightly convex sides. Cingulum is 4—5 μ wide. The laesurae do not reach the inner contour of the cingulum. The torus is 2—3 μ wide and narrows toward its distal end. Both surfaces are smooth.
Maximum size: 40—50 μ.
Holotype: Plate IV, 5, 6, slide D_3—20, co-ordinates 14.3/120.9.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: From the locality type.
Occurrence: For the time being, this species is only known from the type locality.

2. *Croxtonaesporites daniensis* n. fsp. (Plate IV, fig. 7, 8)

Diagnosis

Equatorial contour triangular, generally straight or only very slightly convexe or concave sides. The laesurae of the tetrad scar reach or almost reach, the inner edge of the cingulum. The inner side of the torus is undulating. The torus is 2—2.5 μ wide. Around the torus it is a other torus-like triangular-like thickening which is 2 μ wide. The cingulum is 3 μ wide.
Maximum size: 37—45 μ.
Holotype: Plate IV, 7, 8, slide D_2—1—7, co-ordinates 12.6/122.5.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.

Derivatio nominis: From Denmark.
Differential diagnosis: The so called double torus distinguished this taxon from the former form-species.
Occurrence: For the time being, this species is only known from the type locality.

Fgen.: CONTIGNISPORITES DETTMANN 1963.

1. *Contignisporites* fsp. (Plate IV, fig. 9, 10)

Occurrence: Højrup.
Botanical affinity: Ancestral type *Schizaeaceae* spore.
Remark. — This form-genus is well known from the Jurassic. It is possible that during lower Danian time the fern that produced these spores was still extant. But on the other hand, it is not impossible that these spores are reworked from older sediments.

Fgen.: POLYPODIACEOISPORITES R. POT. 1956 non 1951.

1. *Polypodiaceoisporites triangulus* KDS, and J. R. 1965 (Plate IV, fig. 11, 12)

Occurrence: Stevns Klint.
Botanical affinity: *Pteridaceae.*

2. Cf. *Polypodiaceoisporites* fsp. (Plate IV, fig. 13, 14)

Occurrence: Højrup.

3. *Polypodiaceoisporites brejanii* CERNJAVSKA 1970 (Plate V, fig. 1, 2)

Occurrence: Højrup.
Botanical affinity: *Pteridaceae.*

4. *Polypociaceoisporites vancampoae* KDS. 1967 (Plate V, 3, 4)

Occurrence: Højrup, Stevns Klint.
Botanical affinity: *Pteridaceae.*

5. *Polypodiaceoisporites hojrupensis* n. fsp. (Plate V, 5, 6)

Diagnosis

Equatorial contour is triangular, with straight or slightly convexe sides. The surface of the cingulum is smooth and 3 μ wide. The proximal surface of the central body is ornamented with small verrucae (1—2 μ) or with rugulae with a diameter of 1.5 μ. The laesurae of the tetrad scar reach, or almost reach, the inner edge of the cingulum. The ornamentation of the distal surface of the central body is essentially rugulate, somentimes foveate or reticulate. The muri are 2—3 μ wide.
Maximum size: 40—50 μ.
Holotype: Plate V, 5, 6, slide D_3—41, co-ordinates 20.1/116.3.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: From Højrup the locality type.
Differential diagnosis: The distal ornamentation of the central body is a very distinctive and characteristic feature.
Occurrence: For the time being, this taxon is only known from the type locality.
Botanical affinity: *Pteridaceae.*

6. *Polypodaiceoisporites maximus* E. NAGY and L. RÁKOSI 1966 (Plate V, 7, 8)

Occurrence: Højrup, Stevns Klint.
Botanical affinity: *Pteridaceae.*

7. *Polypodiaceoisporites snopkovae* KDS. 1973 (Plate V, 9, 10)

Occurrence: Højrup, Højstrup.
Botanical affinity: *Pteridaceae.*

8. *Polypodiaceoisporites hungaricus* KDS. 1961 (Plate V, 11, 12)

Occurrence: Højrup.
Botanical affintiy: *Pteridaceae.*

9. *Polypodiaceoisporites stockmarrii* n. fsp. (Plate V, fig. 13, 14)

Diagnosis

Equatorial contour is triangular, generally with straight or only slightly convex or concave sides. The contour of the cingulum is slightly undulating, 4—5 μ wide on the sides and 3 μ on the apices. The laesurae of the tetrad scar are slightly undulating and extend to the inner margin of the cingulum. The proximal surface of the central body is verrucate or rugulate, the diameter of the ornamental elements ranges from 2—6 μ.
Maximum size: 20—30 μ.
Holotype: Plate V, 13,14, slide Stevns Klint—14, co-ordinates 8.7/121.2.
Locus typicus: Stevns Klint.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. J. STOCKMARR.
Differential diagnosis: The new form-species separate well from *P. hungaricus* KDS. 1961 byits equatorial contour.
Occurrence: From the time being it is only known from the type locality.
Botanical affinity: *Pteridaceae.*

10. *Polypodiaceoisporites gracicingulis* W. KR. 1959 (Plate VI, fig. 1, 2)
Occurrence: Højrup.
Botanical affinity: *Pteridaceae.*

11. *Polypodiaceoisporites granulatus* KDS. 1966b (Plate VI, fig. 3, 4)
Occurrence: Højrup.
Botanical affinity: *Pteridaceae.*

12. *Polypodiaceoisporites bangii* n. fsp. (Plate VI, fig. 5, 6)

Diagnosis

Equatorial contour is triangular with rounded apices and slightly convexe or concave sides. The surface of the cingulum is smooth, 3 μ wide. The laesurae of the tetrad scar do not reach the inner margin of the cingulum, r=3/4 in average. Near, the laesurae, the verrucae are aligned. The basal diameter of the verrucae is 1—2 μ the diameter of the rugulae is 2 μ. On the distal side of the central body, there is a triangular thickened form; near this thickening there are rugulae. The elements of this ornamentation are 1.5 μ wide.
Maximum size: 40—50 μ.
Holotype: Plate VI, 5, 6, slide Højstrup—2, co-ordinates 2.8/106.7.
Locus typicus: Højstrup.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. I. BANG.
Differential diagnosis: The characteristic thickening of the distal side of the central body makes this species distinct from the other taxa of the *Polypodiaceoisporites*, with similar great size.
Occurrence: From the time being, it is only known from the locality type.
Botanical affinity: *Pteridaceae.*

13. *Polypodiaceoisporites croxtonae* n. fsp. (Plate VI, 7, 8)

Diagnosis

Equatorial contour is triangular, with concave sides. The cingulum is 2.5—3 μ wide. The proximal surface of the central body is ornamented with granules of 1 μ diameter. The laesurae of the tetrad scar extend to the inner margin of the cingulum. Around the laesurae there is a characteristic thickening. The distal surface of the

central body is finely granular, the size of the ornamental elements is 0.5 μ; sometimes the ornamentation is finely reticulate or rugulate.
Maximum size: 16—23 μ.
Holotype: Plate VI, 7, 8, slide D_3—72, co-ordinates 13.5/111.2.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. I. C. CROXTON.
Differential diagnosis: The smaller size, and the sculpture of the central body distinguish this species from *P. obuncus* W. KR. 1959, and *P. microconcavus* W. KR. 1967.
Occurrence: For the time being, this taxon in only known from the type locality.
Botanical affinity: *Pteridaceae.*

14. *Polypodiaceoisporites laevigatus* KDS. and J. R. 1965 (Plate VI, fig. 13, 14)
Occurrence: Højstrup.
Botanical affinity: *Pteridaceae.*

15. *Polypodiaceoisporites haemussensis* CERNJAVSKA 1966 (Plate VI, fig. 15, 16)
Occurrence: Dania.
Botanical affinity: *Pteridaceae.*

Fgen.: VERRUCINGULATISPORITES KDS. 1961.

1. *Verrucingulatisporites hojrupensis* n. fsp. (Plate VI, fig. 9, 10)

Diagnosis

Equatorial contour is triangular, with concave sides, the apices are rounded. The width of the cingulum is variable and is between 5 and 10 μ. The verrucae on the cingulum are between 3—5 μ high. The proximal side of the central body is ornamented with flat verrucae, there are very characteristic at the end of the laesurae. The laesurae does not reach the inner margin of the cingulum, r=1/2—3/4. The distal surface of the central body is verrucate-rugulate, the size of the ornamental elements is around 3 μ.
Maximum diameter: 32—40 μ.
Holotype: Plate VI, 9,10, slide D_3—61, co-ordinates 8.9/108.3.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: From the locality type.
Differential diagnosis: The most characteristic and distinctive feature of this species is the ornamentation of the cingulum.
Occurrence: For the time being this taxon is only known from the type locality.
Botanical affinity: *Pteridaceae.*

Fgen.: SEGMENTIZONOSPORITES KDS. 1966b.

1. *Segmentizonosporites daniense* n. fsp. (Plate VI, fig. 11, 12)

Diagnosis

Equatorial contour is triangular with slightly convex sides. The zona is 6 μ wide on the sides and 3 μ wide at the apices. The laesurae of the tetrad scar are long, but do not extend to the inner margin of the cingulum; r=3/4. The proximal side of the central body is covered with granules, but these granules anastomose often so that the surface appears finely rugulate. The distal part of the central body is less characteristic, the ornamental elements are tiny granules — 0.5 μ in size, and finely rugulate. On the border of the cingulum and the central body there are granules with a diameter of 1—2 μ.
Maximum size: 30—36 μ.
Holotype: Plate VI, 11, 12, slide D_2—1—6, co-ordinates 23.1/121.6.

Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: From Dania.
Differential diagnosis: The small ornamental elements of the central body distinguish this taxon well from the other species of this form-genus.
Occurrence: For the time being, this species is only known from the type locality.
Botanical affinity: Based on the publication of KREMP (1967), *Pteridaceae: Taenitis blechnoides,* pl. I, 36, 37.

Fgen.: HAMULATISPORIS W. KR. 1959.

1. *Hamulatisporis heskemensis* (PFLANZL 1955) n. comb. (Plate VII, fig. 3, 4)

Syn.: 1955. PFLANZL, in MÜRRIGER and PFLANZL, *Cingulatisporites heskemensis* n. sp., p. 85, pl. 5, 1—3.

1959. — KRUTZSCH, *Camarozonosporites heskemensis* (PFLANZL 1955) n. comb., p. 187.

Occurrence: Højstrup.

Fgen.: INUNDATISPORIS W. KR. 1963 stat. nov. Syn.: *Camarozonosporites* (*Inundatisporis* W. KR. 1963)

1. *Inundatisporis krutzschii* n. fsp. (Plate VII, fig. 1, 2)

Diagnosis

Equatorial contour triangular, convex, sometimes nearly circular. The laesurae of the tetrad scar reach the equator, but before the equator they divide. The sculpture, on both sides is hamulate, the sculptural elements are 0.5—1 μ wide.
Maximum size: 45—50 μ.
Holotype: Plate VII, 1, 2, slide Dania—29, co-ordinates 17.2/115.1.
Locus typicus: Dania.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. W. KRUTZSCH.
Differential diagnosis: The large size of this species and the fine sculpture distinguish it from the other members of this form-genus.
Occurrence: For the time being, this taxon is only known from the type locality.
Botanical affinity: *Lycopodiaceae.*

Fgen.: ALISPORITES DAUGHERTY 1941.

1. *Alisporites* cf. *bilateralis* ROUSE 1959 (Plate VII, 5, 6)

Occurrence: Højrup.
Botanical affinity: *Abietales.*

Fgen.: PITYOSPORITES SEWARD 1914.

1. *Pityosporites labdacus* (R .POT. 1931) TH. and PF. 1953 subfsp. *labdacus* (Plate VII, 7, 8)

Occurrence: Højrup, Dania.
Botanical affinity: *Abietaceae, Pinus.*

Fgen.: PARVISACCITES COUPER 1958.

1. *Parvisaccites* fsp. (Plate VII, fig. 9, 10)

Occurrence: Højrup.
Botanical affinity: *Coniferopsida.*

DISCUSSION

In the earlier published work of this investigation, 57 *Angiospermatophyte* pollen form-species, now 3 *Gymnospermatophyte* pollen, and 47 spore form-species were described. From the vegetational evolutionary and stratigraphical point of view, the abundance of the zonotrilete spores is noteworthy. The origin is of these spores is to be found in the Lower Cretaceous. But they are known in greater quantity from the Cenomanian. The acme (golden age) of these forms probably occurring at the Cretaceous-Tertiary transition. This is worth mentioning, because the well known tropical fern families (e. g. *Gleicheniaceae, Schizaeaceae*) are present in the largest quantity in the lower Cretaceous BOLKHOVITINA (1966, 1967, 1968). The livermoss spores represent a marsh vegetation.

The very small quantity of the *Gymnospermous* pollen grains is interesting. It seems that during the lower Danian there was not autochtonous *Classopollis* or *Classoidites*. The extinction of these probable *Cheirolepidaceae* taxa are distinct from those of the Maestrichtian. In addition, a number of species of gymnospermous pollen with bladders occur in high quantity first in the Thanetian of the Paleocene. If we accept that the *Normapolles* producing plants were shrubs in a marsh vegetation, we may assume a series of extinction in the Lignosa — tree taxa. This view is supported by the *Pteridophyta/Angiospermatophyta* ratio.

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EXPLANATION OF PLATES

PLATE I

1, 2. — *Leiotriletes hojrupensis* n. fsp., *Schizaeaceae,* cf. *Lygodium,* D_2—1—3; 6.4/110.2.
3, 4. — *Cyathidites minor* COUPER 1953, *Cyatheaceae,* D_2—2—1; 20.5/123.4.
5, 6. — *Triremisporites delcourti* DÖRING 1965, *Gleicheniaceae,* Højstrup—39; 20.2/109.6.
7, 8. — *Triremisporites minor* n. fsp., *Gleicheniaceae,* D_3-1—5; 9.6/108.3.
9, 10. — *Concavisporites laeviconcavus* W. KR. 1959, *Gleicheniaceae,* D_2—1—7; 20.2/120.1.
11, 12. — *Obtusisporis obtusangulus* (R. POT. 1934) W. KR. 1959, *Gleicheniaceae,* D_2—1—7; 9.8/122.2.
13, 14. — *Obtusisporis obtusangulus* (R. POT, 1934) W. KR. 1959, *Gleicheniaceae,* D_2—1—x—4; 5.8/102.7.
15. 16. — *Obtusisporis minimus* W. KR. 1962, *Gleicheniaceae,* D_3—82; 4.5/107.5.
17, 18. — *Obtusisporis minimus* W. KR. 1962, *Gleicheniaceae,* D_3—78; 17.2/109.6.
19, 20. — *Disthamulatisporites daniensis* n. fgen. et fsp., *Gleicheniaceae,* D_2—1—x—1; 16.5/113.9.
21. 22. — *Disthamulatisporites daniensis* n. fgen. et fsp., *Gleicheniaceae.* D_3—78; 10.2/110.6.
23, 24. — *Undulatisporites undulapolus* BRENNER 1963, *Gleicheniaceae,* D_2—1—x—4; 21.7/116.1.
25, 26. — *Undulatisporites undulapolus* BRENNER 1963, *Gleicheniaceae,* D_3—34; 22.3/121.4.
27, 28. — *Undulatisporites elsikii* FREDERIKSEN 1973, *Gleicheniaceae,* D_3—2; 8.3/106.4.
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PLATE II

1, 2. — *Undulatisporites elsikii* FREDERIKSEN 1973, Stevns Klint-23; 10.4/117.6.
3, 4. — *Biretisporites croxtonae* n. fsp., Stevns Klint—4; 11.4/115.2.
5, 6. — *Granulatisporites concavus* n. fsp., Højstrup—1; 16.4/104.5.
7, 8. — *Ischyosporites asolidus* (. W. KR. 1959) W. KR. 1967, *Schizaeaceae, Lygodium.* D_3—19; 5.5/104.6.
9, 10. — *Trilites triangulus* KDS. 1966, *Schizaeaceae, Lygodium,* Højstrup—4; 19.6/115.7
11, 12. — *Trilites paravallatus* W. KR. 1959, *Schizaeaceae, Lygodium.* D_2—1—x—8; 19,7/104.1.
13, 14. — *Verreticulisporis bangii* n. fsp., D_3—1—x—8; 19.7/104.1.
15. — *Verrucosisporites stockmarrii* n. fsp., *Osmundaceae* or *Schizaeaceae,* Højstrup—49; 8.6/111.9.
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PLATE III

1. — *Verrucosisporites stockmarrii* n. fsp., *Osmundaceae* or *Schizaeaceae,* Højstrup—49; 8.6/111.9.
2, 3. — *Foveotriletes* fsp., Stevns Klint—26; 18.6/115.3.
4, 5. — *Retitriletes incomptus* (MANUM 1962) W. KR. 1963, *Lycopodiaceae,* D_2—2—5; 6.3/125.1.
6, 7. — *Saxosporis* fsp. ex group *gracilis* W. KR. and PACLTOVÁ 1963, *Anthocerotaceae, Phaeoceros,* D_3—64; 17.7/115.1.
8, 9. — *Saxosporis disconformis* (STOVER 1973) n. comb., *Anthocerotaceae,* Stevns Klint—7; 18.6/107.3.
10, 11. — *Echinatisporis* fsp., *Selaginellaceae, Selaginella,* Højstrup—24; 16.5/103.4.
12, 13. — *Phaeocerosporites croxtonae* n. fsp., *Anthocerotaceae,* Højstrup—50; 14.3/103.8.
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PLATE IV

1, 2. — *Phaeocerosporites stockmarrii* n. fsp., *Anthocerotaceae*, Højstrup—6; 7.4/107.0.
3, 4. — *Phaeocerosporites bangii* n. fsp., *Anthocerotaceae*, Stevns Klint—20; 5.1/102.8.
5, 6. — *Croxtonaesporites hojrupensis* n. fsp., D_3—20; 14.3/120.9.
7, 8. — *Croxtonaesporites daniensis* n. fsp., D_2—1—7; 12.6/122.5.
9, 10. — *Contignisporites* fsp., D_3—40; 8.2/120.5.
11, 12. — *Polypodiaceoisporites triangulus* KDS. and J. R. 1965, *Pteridaceae*, Stevns Klint—13; 3.4/118.3.
13, 14. — Cf. *Polypodiaceoisporites* fsp., D_3—77; 17.8/124.3.
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PLATE V

1, 2. — *Polypodiaceoisporites brejanii* CERNJAVSKA 1970, *Pteridaceae*, D_3—79; 4.2/103.8.
3, 4. — *Polypodiaceoisporites vancampoae* KDS. 1967, *Pteridaceae*, Stevns Klint—9; 21.7/111.2.
5, 6. — *Polypodiaceoisporites hojrupensis* n. fsp., *Pteridaceae*, D_3—41; 20.1/116.3.
7, 8. — *Polypodiaceoisporites maximus* E. NAGY and L. RÁKOSI 1966, *Pteridaceae*, D_3—71; 23.3/116.4.
9, 10. — *Polypodiaceoisporites snopkovae* KDS. 1973, *Pteridaceae*, D_2—2—x—4; 13.6/122.5.
11, 12. — *Polypodiaceoisporites hungaricus* KDS. 1961, *Pteridaceae*, D_3—1—x—10; 4.7/105.0.
13, 14. — *Polypodiaceoisporites stockmarrii* n. fsp., *Pteridaceae*, Stevns Klint—14; 8.7/121.2.
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PLATE VI

1, 2. — *Polypodiaceoisporites gracicingulis* W. KR. 1959, *Pteridaceae*, D_3—32; 13.7/103.2.
3, 4. — *Polypodiaceoisporites granulatus* KDS. 1966, *Pteridaceae*, D_2—1—x—6; 2.7/111.5.
5, 6. — *Polypodiaceoisporites bangii* n. fsp., *Pteridaceae*, Højstrup—2; 2.8/106.7.
7, 8. — *Polypodiaceoisporites croxtonae* n. fsp., *Pteridaceae*, D_3—72; 13.5/111.2.
9, 10. — *Verrucingulatisporites hojrupensis* n. fsp., *Pteridaceae*, D_3—61, 8.9/108.3.
11, 12. — *Segmentizonosporites daniense* n. fsp., *Pteridaceae*, D_2—1—6; 23.1/121.6.
13, 14. — *Polypodiaceoisporites laevigatus* KDS. and J. R. 1965, *Pteridaceae*, Højstrup—49; 4.2/104.7.
15, 16. — *Polypodiaceoisporites haemussensis* CERNJAVSKA 1966, *Pteridaceae*, Dania—35; 14.4/112.3.
×1000

PLATE VII

1, 2. — *Inundatisporis krutzschii* n. fsp., *Lycopodiaceae*, Dania—29; 17.2/115.1.
3, 4. — *Hamulatisporis heskemensis* (PLANZL 1955) n. comb., *Lycopodiaceae*, Højstrup—29; 7.0/108.3.
5, 6. — *Alisporites* cf. *bilateralis* ROUSE 1959, *Abietales*, D_3—41; 23.2/111.1.
7, 8. — *Pityosporites labdacus* (R. POT. 1931) TH. and PF. 1953 subfsp. *labdacus*, *Abietaceae*, *Pinus*. Dania—24; 4.7/113.7.
9, 10. — *Parvisaccites* fsp., *Coniferopsida*, D_3—6; 23.6/111.2.
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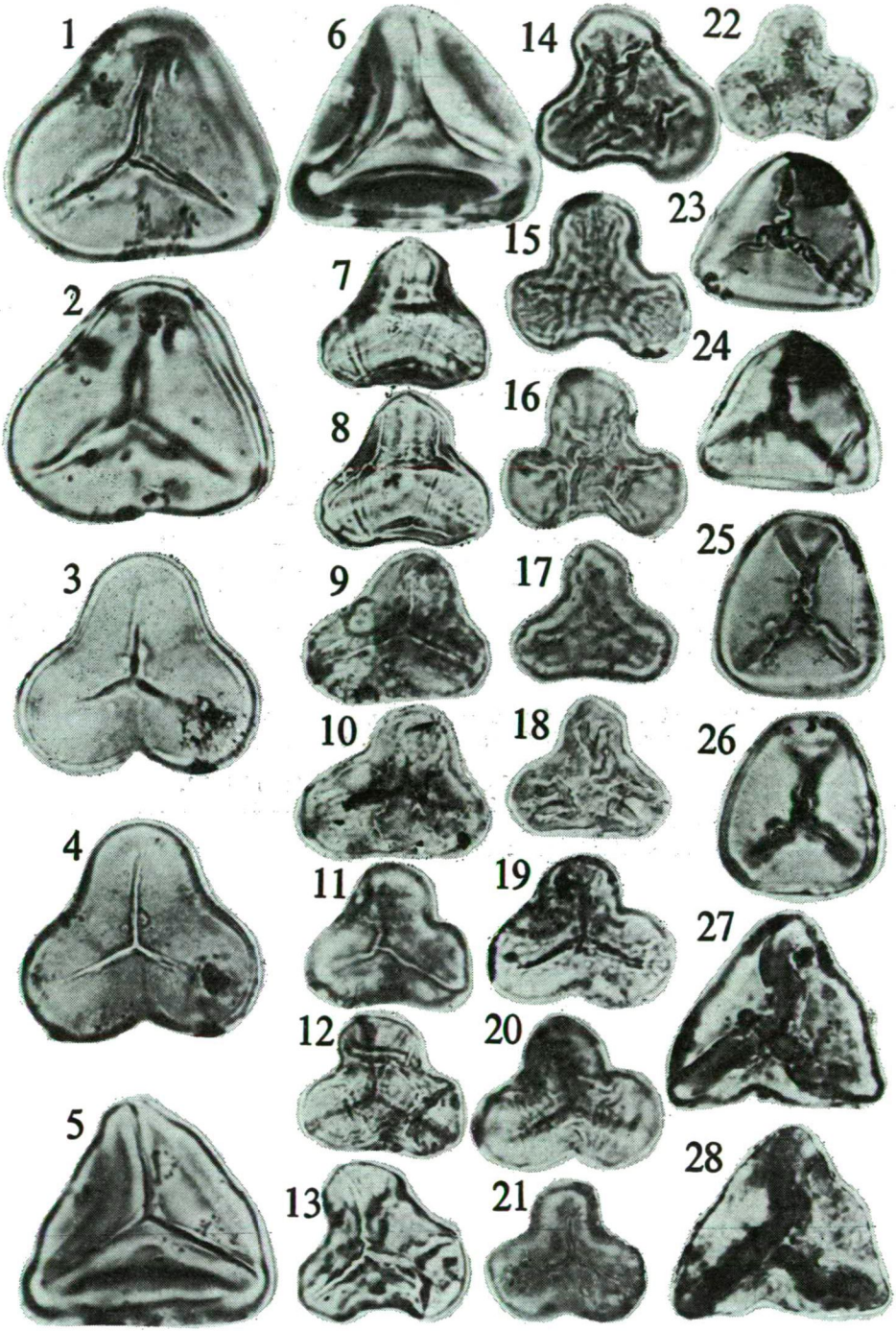
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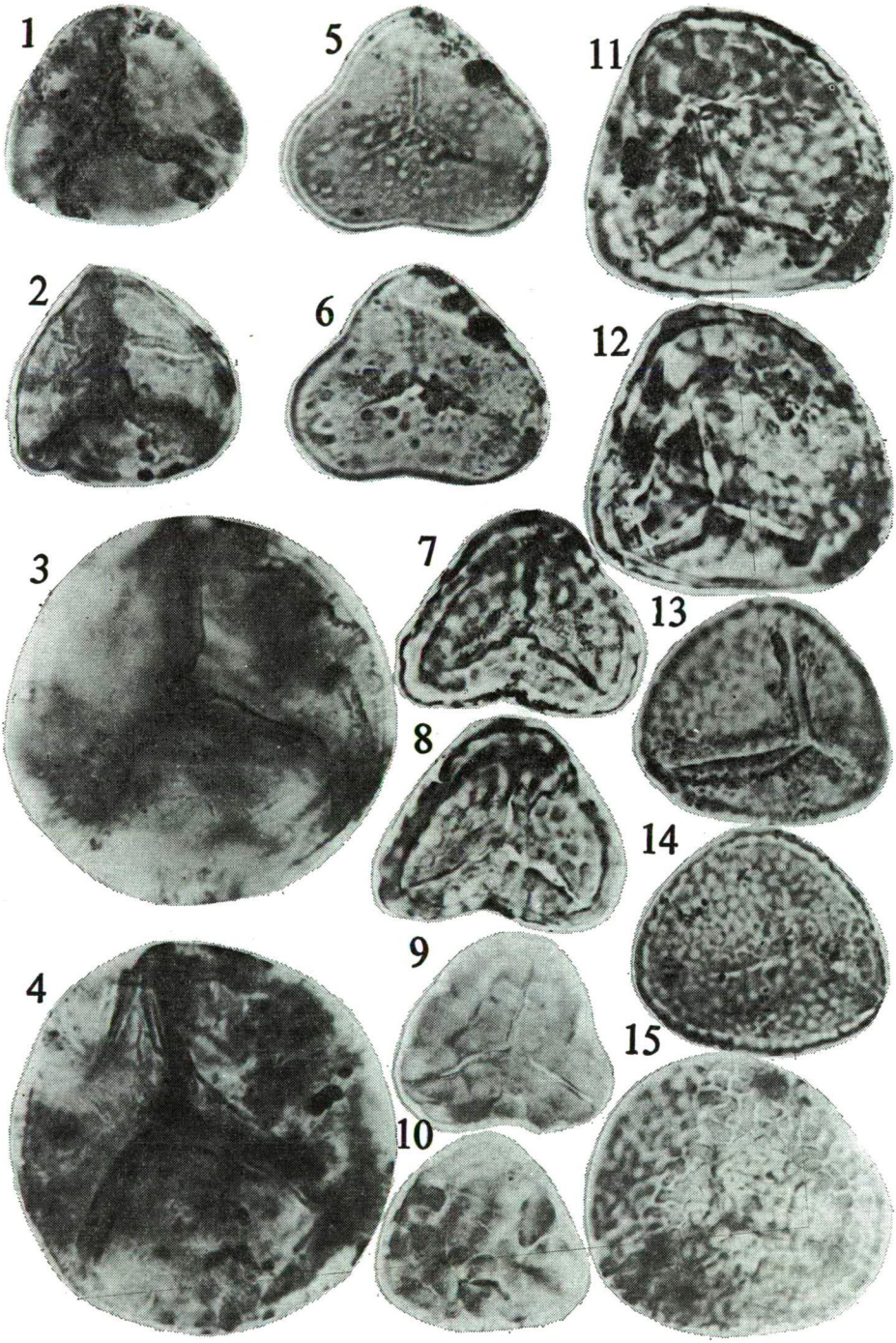
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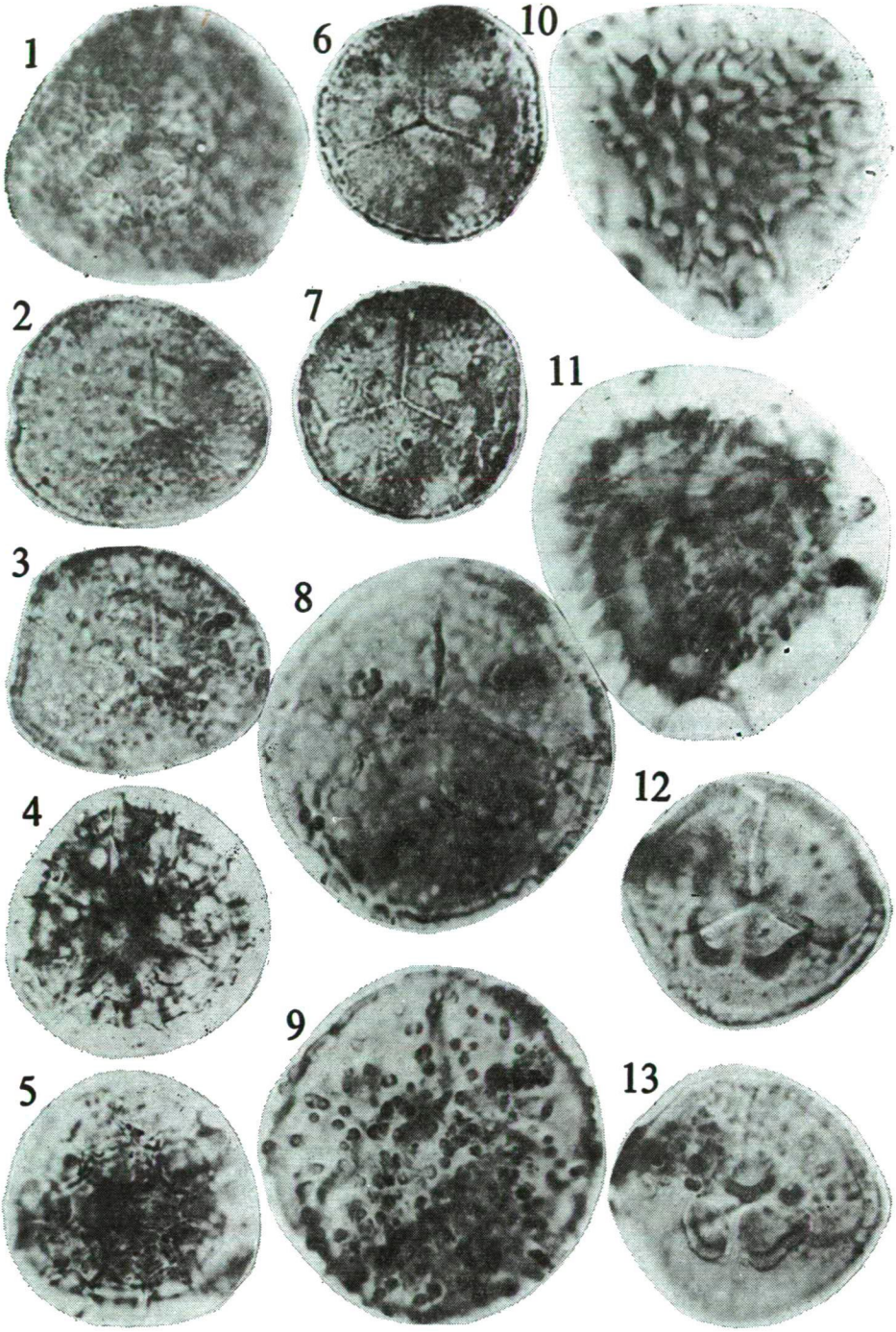
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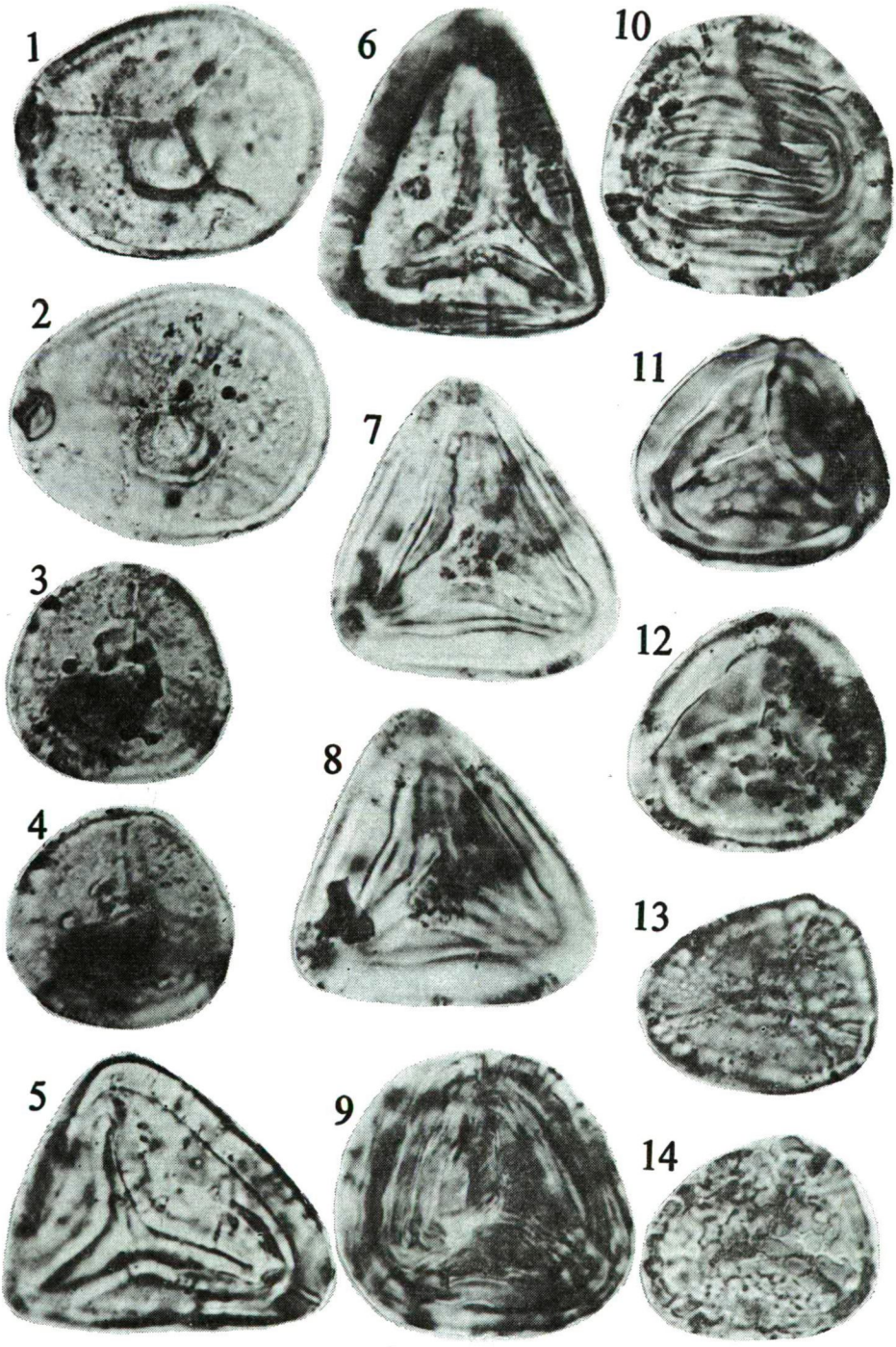
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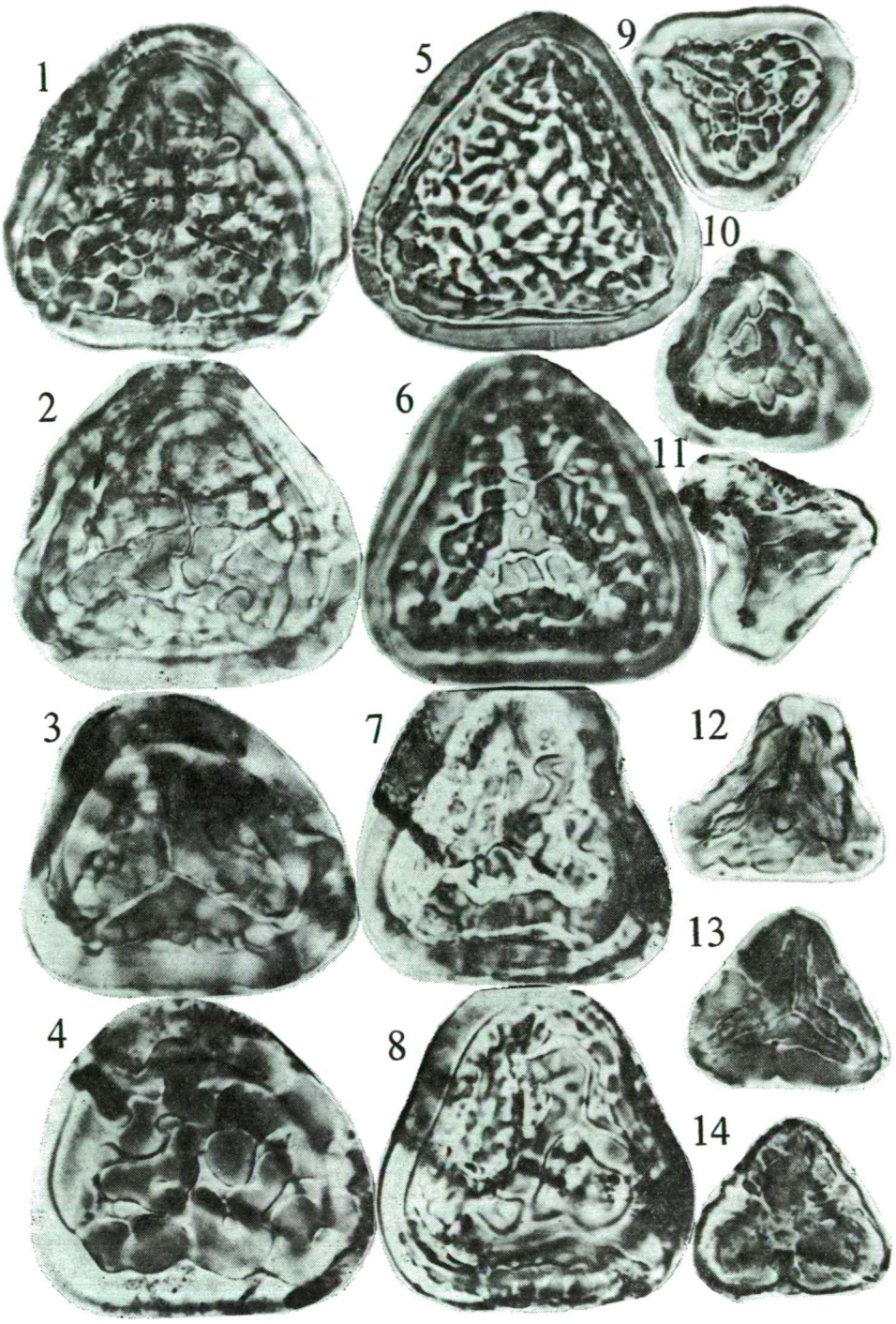
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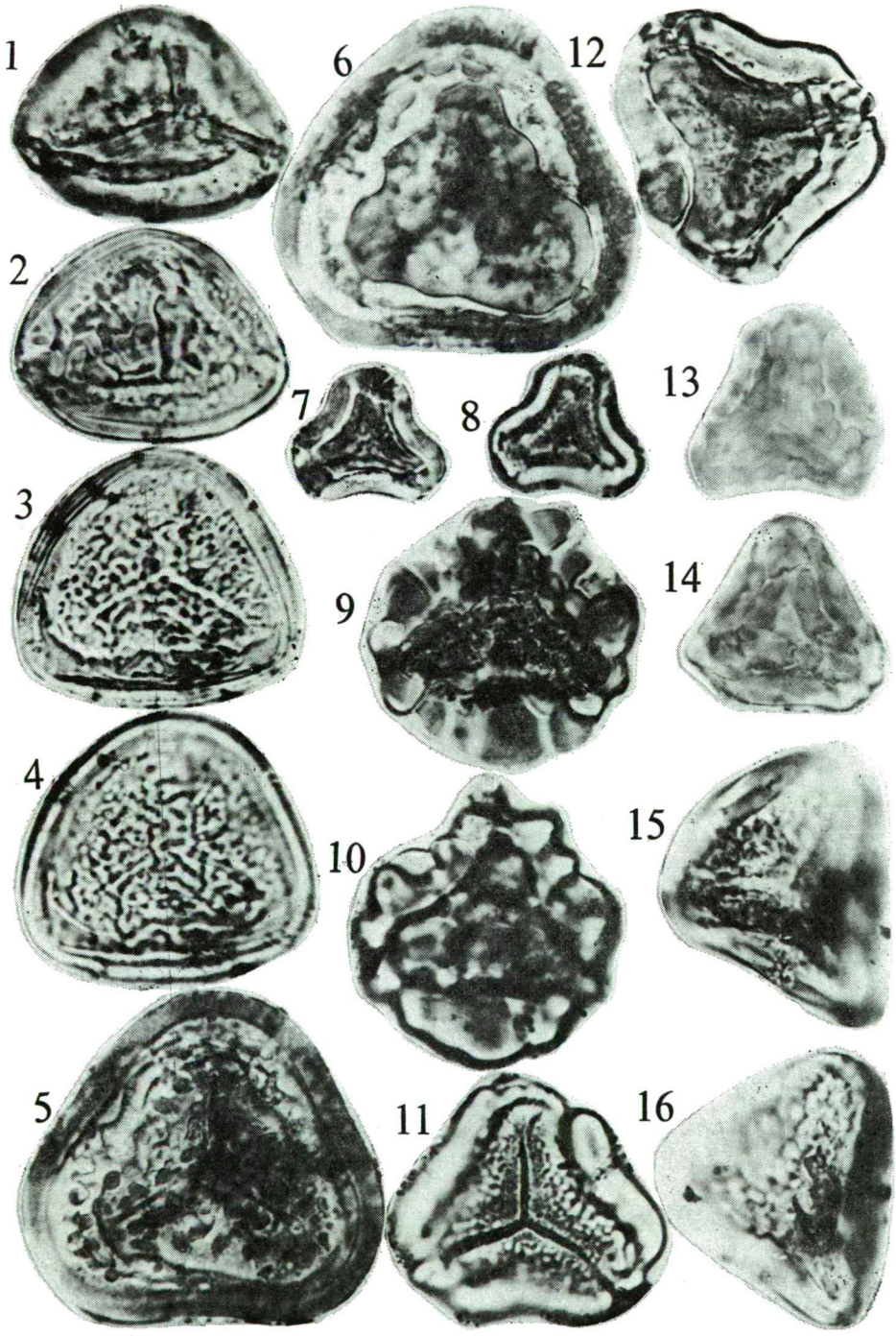
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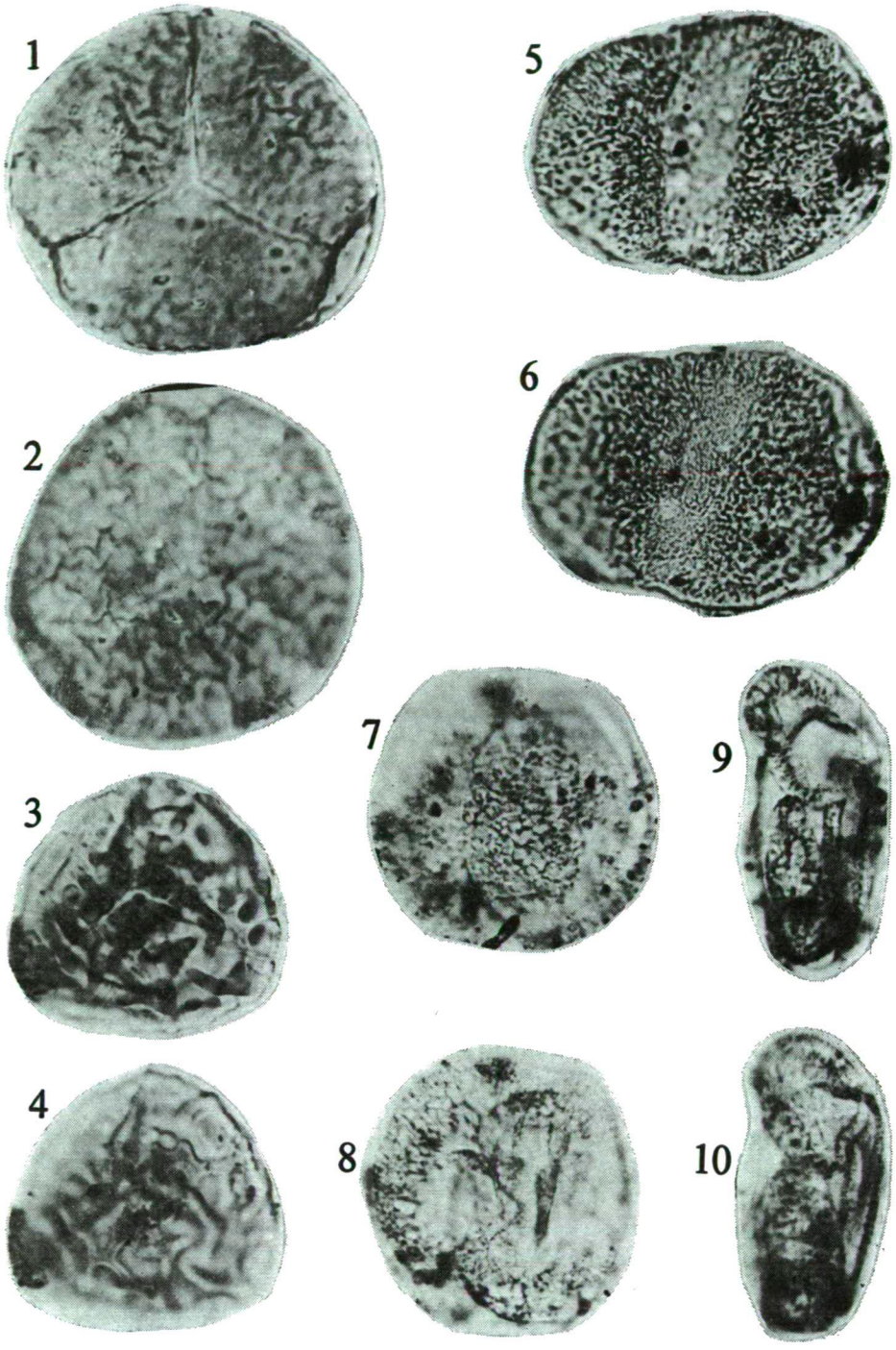
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